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Formulation of protein rich mixes and evaluation of its suitability for product development

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Abstract
Dietary protein plays a critical role in countless physiological processes in the body. The current Recommended Dietary Allowance (RDA) for healthy individuals is 1g/kg body weight/day. It is evident that, adequate intake of protein is essential for overall healthy living of the individuals. Milk contains all the essential nutrients for all physiological functions of the body system. Application of drying technologies on dairy products, specifically milk, ensure microbiological safety and extends the shelf life providing an opportunity to develop protein rich products having extended shelf life. Hence combination of ingredients can be used to develop high protein mixes. In the present study six high protein mixes were prepared and products like dosa, soup and laddu were prepared with all the formulations. Among the six formulations, formulation 3 has highest sensory scores for soup, dosa and laddu in common. So, formulation 3 is selected for the evaluation of nutritional parameters. The proximate composition of selected formulation was Moisture: 8.90%; Protein: 17.2%; Fat: 1.83%; Ash: 1.5%; Crude fibre: 2.12%; Carbohydrate: 67.60%; Energy: 355.33 K. Cal. Thus, from the present study it can be concluded that skim milk powder, little millet flour and green gram dhal in combination can be used effectively to develop protein rich mix.

Keywords: Skim milk powder (SMP), little millet, high protein, Dosa, Laddu

Introduction
Dietary protein plays a critical role in countless physiological processes in the body. The current Recommended Dietary Allowance (RDA) for healthy individuals is 1g/kg body weight/day. It is evident that, adequate intake of protein is essential for overall healthy living of the individuals. On the other hand the problem of malnutrition is high and percentage of population having in-adequate accesses to protein rich foods still remains higher especially among children, pregnant and lactating mothers. Hence development, evaluation and marketing of low protein rich foods will address the problem of malnutrition. Milk contains all the essential nutrients for all physiological functions of the body system. Application of drying technologies on dairy products, specifically milk, ensure microbiological safety and extends the shelf life providing an opportunity to develop protein rich products having extended shelf life. Hence forth milk powder can be used effectively in developing protein rich products for ensuring nutritional security (especially with respect to protein). SMP is obtained from full-fat milk after the partial removal of fat and water. SMP contains a maximum of 1% fat. The nutrient composition of skim milk powder is moisture (4%), casein (27%), fat (1%), lactose (51%), whey protein (6.6%) and ash (8.5%). (Walstra, *et al.* 2005) [17] Along with malnutrition twenty first century is becoming challenging with issues like climate change, water scarcity, increasing world population, rising food prices, and other socio economic problems. Henceforth there is a threat to agriculture and food security worldwide, especially for the poorest people who live in arid and sub-arid regions. Hence, there is a need for alternative nutritive food source which can ensure food and nutrition security effectively Thus, focus can be shifted to small-grain cereals, notably millets. Millets are more reliable as they produce a harvest even under adverse growing conditions. (Kulakarni *et al.*, 2018; Rao *et al.*, 2017) [9, 13]. The most important major millets cultivated in India are pearl millet (*Pennisetum glaucoma*), foxtail millet (*Setaria italica*), proso millet (*Panicum miliaceum*) and finger millet (*Eleusine coracana*) and also minor millets like barnyard millet (*Echinochloa esculenta*), kodo millet (*Paspalum scrobiculatum*), little millet (*Panicum sumatrense*) etc., (Nishad *et al.*, 2017) [10].

Millets are important nutritional bio sources due to its richness in starch, protein, fiber, niacin, magnesium, phosphorus, manganese, iron, potassium, essential amino acids and vitamin E. In addition to being as a good source of nutrients, millets have various therapeutic benefits such as prevention of heart diseases, diabetes, migraine, cancer and gastro intestinal diseases (Das and Rakshit, 2016) [7]. Little millet is a fair source of protein (7.70 to16.50%), fat (2.45 to 9.04%), carbohydrates (62.50 to 76.30%), and an excellent source of dietary fiber (15.90 to 18.10%) with good amount of soluble (3.15 to 5.70%) and insoluble fractions (10.20 to 14.95%). Besides, it also contains appreciable amounts of minerals such as iron (9.30 to 20.00 mg/100 g), magnesium (133 mg/100 g) and zinc (3.70 mg/100 g) (Patil *et al*., 2014) [11]. Based on the above evidences the present work is aimed in developing protein rich mix with little millet, skimmed milk powder and green gram dhal. As the nutritional quality of cereals protein will be improved by supplementation with legume protein, green gram dhal also being a good source of protein was also used in the formulation of instant soup mixes to make it nutritionally rich.

Materials and Methods

The present study was conducted at Department of Food Science and Nutrition, University of agricultural sciences, Dharwad, Karnataka.

Selection and procurement of raw material

Little millet, green gram dhal, Skim milk powder and other ingredients were procured from local markets of Dharwad.
All the chemicals and glassware were procured from Department of Food Science and Nutrition, University of agricultural sciences, Dharwad, Karnataka.

Formulation of protein rich mixes

Total 6 mixes were formulated with little millet, skim milk powder, green gram dhal flour, and skim milk powder. Same procedure was followed for the preparation of all mixes. Cleaned little millet and green gram dhal were roasted for 7-10 minutes and were made into flour individually. Then the ingredients were mixed according the formulations presented in the table 1

Table 1: Formulation of mixes

Formulation	Little millet (%)	Skim Milk Powder (%)	Corn flour (%)	Green gram dhal flour (%)
1	10	60	10	20
2	20	50	10	20
3	30	40	10	20
4	40	30	10	20
5	50	20	10	20
6	60	10	10	20

Development of products from the formulated mixes and selection of best accepted formulation

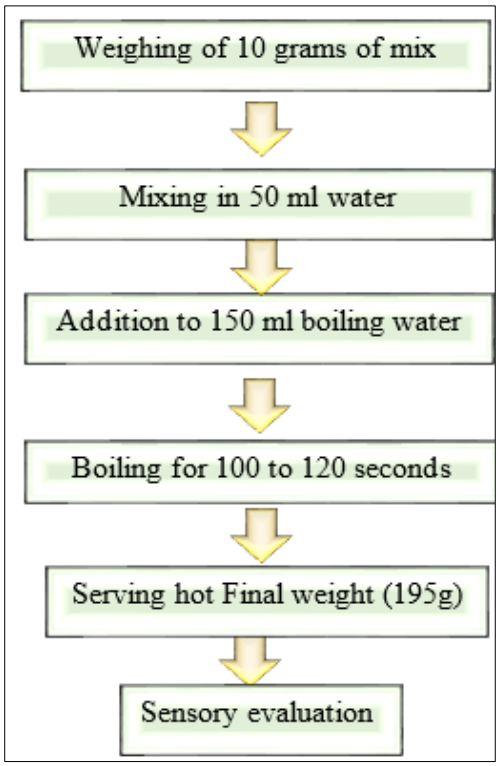

Fig 1: Procedure for preparation of soup mix 1 serving

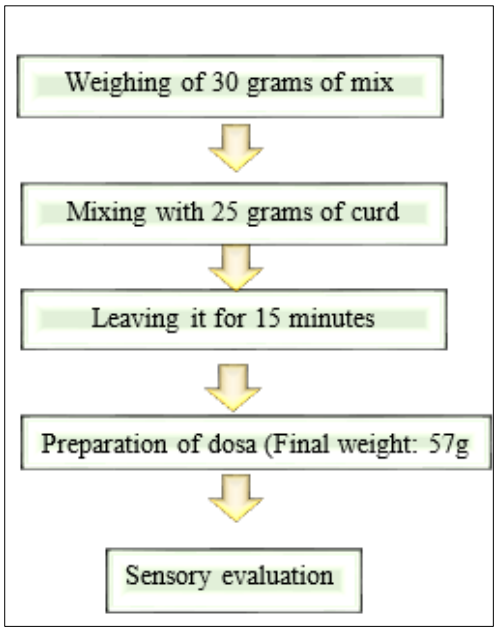

Fig 2: Procedure for preparation of dosa (1 serving: 1 in number)

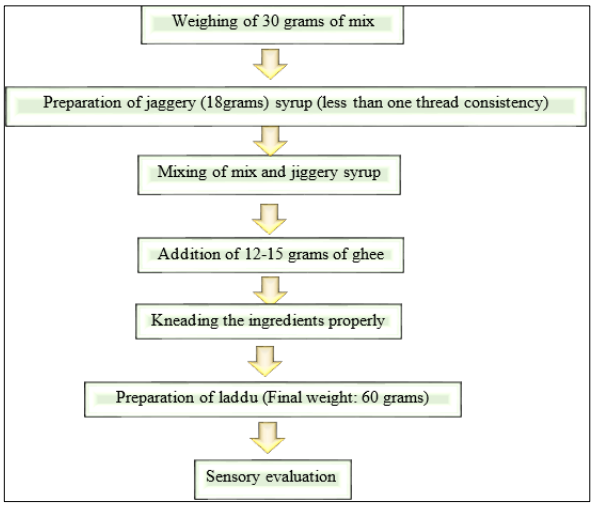

Fig 3: Procedure for preparation of laddu (1 serving: 2 in number)

Assessment of quality parameters of the selected formulation

Assessment of proximate composition of the selected formulation

Moisture content of samples was analysed by the standard procedure of AOAC, (2005) [4].

Protein content of the samples was analysed by the standard procedure of AOAC, (2005) [5].

Fat content of the samples was analysed by the standard procedure of AOAC, (1997) [3].

Ash content of the samples was analysed by the standard procedure of AOAC, (2005) [4] using Centex digital muffle furnace.

Crude fibre content of the samples was analysed by the standard procedure of AOAC, (1990) [2].

Carbohydrate content of the samples was computed by the standard procedure of AOAC, (1980) [1]. Carbohydrate content was computed by subtracting the total of moisture, protein, fat, ash and crude fiber from 100. Carbohydrate (g) = 100 – (moisture + protein + fat + ash + crude fibre).

Energy content of samples was computed by the standard procedure of AOAC, (1980) [1]. Energy content was computed by multiplying protein, fat and carbohydrate values obtained from analysis by 4, 9 and 4 respectively and expressed as K. Cal/100 g.

Energy (K. Cal) = (Protein×4) + (Fat×9) + (Carbohydrates×4).

Results and Discussion

The aim of the present study development and evaluation of protein rich mix was to investigate the possibility of developing protein rich mixes with skim milk powder, little millet, green gram dhal flour and corn flour without affecting the organoleptic properties and to enhance the nutritional profile of soups. Hence mixes were developed with varying proportions of little millet flour and skim milk powder. The developed mixes were evaluated for the sensory properties by preparing soup, laddu and dosa. Best accepted mix nutritional parameters were evaluated. Appropriate statistical methods were used to analyse the results and were discussed with the help of tables. Results pertaining to the study were presented under the following sections. Sensory properties of the developed products Proximate composition of the best accepted mix

Sensory properties of the developed products

Table 2: Sensory properties of soups

Soups	Colour	Appearance	Taste	Flavour	After Taste	Consistency	Overall acceptability
Formulation 1	6.81 ± 0.24	6.76 ± 0.22	6.71 ± 0.36	6.57 ± 0.28	6.57 ± 0.2	6.52 ± 0.33	6.66 ± 0.26
Formulation 2	7.09 ± 0.20	7.14 ± 0.21	7.66 ± 0.28	7.85 ± 0.18	6.36 ± 0.23	6.95 ± 0.22	6.90 ± 0.23
Formulation 3	7.61 ± 0.29	8.71 ± 0.29	8.33 ± 0.38	8.33 ± 0.39	7.68 ± 0.18	8.42 ± 0.33	8.75 ± 0.29
Formulation 4	7.14 ± 0.18	7.04 ± 0.20	6.81 ± 0.19	6.57 ± 0.21	6.21 ± 0.22	7.38 ± 0.24	7.00 ± 0.19
Formulation 5	6.95 ± 0.24	6.90 ± 0.27	6.38 ± 0.28	6.61 ±0.24	6.50 ± 0.27	6.90 ± 0.24	6.810 ± 0.25
Formulation 6	6.90 ± 2.20	6.76 ± 0.26	5.19 ± 0.32	5.61 ± 0.24	6.80 ± 0.30	6.71 ± 0.29	6.71 ± 0.30
F- value	1.29	1.04	2.76	2.05	1.08	2.46	2.16
Probability	0.02^{NS}	0.03^{NS}	0.32*	0.03*	0.04^{NS}	0.02*	0.03*

Values are expressed as mean ± SD, *Significant at 5% level, NS: not significant

Table 3: Sensory properties of Dosa

Dosa	Colour	Appearance	Taste	Flavour	After taste	Consistency	Overall acceptability
Formulation 1	6.66 ± 0.19	5.66 ± 0.22	5.64 ± 0.17	6.57 ± 0.17	5.57 ± 0.17	6.81 ± 0.16	5.38 ± 0.17
Formulation 2	6.04 ± 0.21	7.38 ± 0.24	6.38 ± 0.20	6.57 ± 0.20	6.42 ± 0.21	6.19 ± 0.29	6.38 ± 0.17
Formulation 3	8.76 ± 0.16	7.61 ± 0.20	7.81 ± 0.20	7.71 ± 0.20	7.43± 0.20	7.15 ± 0.17	7.51 ± 0.20
Formulation 4	7.81 ± 0.18	7.47 ± 0.17	7.46 ± 0.26	7.57 ± 0.20	7.42 ± 0.28	7.06 ± 0.19	7.12 ± 0.17
Formulation 5	5.29 ± 0.18	6.85 ± 0.15	5.00 ± 0.21	5.85 ± 0.21	6.90 ± 0.21	6.95 ± 0.20	6.85 ± 0.18
Formulation 6	5.00 ± 0.19	5.95 ± 0.17	5.00 ± 0.21	5.04 ± 0.24	5.81 ± 0.25	5.85 ± 0.23	5.00 ± 0.23
F- value	2.21	2.04	2.26	2.05	2.08	2.46	2.16
Probability	0.02*	0.04*	0.03*	0.02*	0.02*	0.01*	0.03*

Values are expressed as mean ± SD, *Significant at 5% level

Table 4: Sensory properties of laddu

Dosa	Colour	Appearance	Taste	Flavour	After taste	Consistency	Overall acceptability
Formulation 1	7.24 ± 0.17	7.23 ± 0.16	6.43 ± 0.16	6.19 ± 0.16	6.23 ± 0.16	7.61 ± 0.10	6.61 ± 0.10
Formulation 2	7.54 ± 0.17	7.42 ± 0.17	7.23 ± 0.16	6.23 ± 0.16	6.23 ± 0.16	7.42 ± 0.17	5.42 ± 0.17
Formulation 3	7.76 ± 0.16	7.61± 0.10	8.85 ± 0.17	7.95 ± 0.17	8.85 ± 0.17	7.32 ± 0.16	7.23 ± 0.16
Formulation 4	7.38± 0.22	7.19 ± 0.16	8.42 ± 0.22	7.42 ± 0.22	7.42 ± 0.22	7.19 ± 0.16	7.19 ± 0.16
Formulation 5	7.76 ± 0.16	7.42 ± 0.11	8.81 ± 0.16	7.81 ± 0.16	7.81 ± 0.16	7.42 ± 0.11	7.42 ± 0.11
Formulation 6	7.57 ± 0.22	7.81 ± 0.08	8.66 ± 0.23	7.66 ± 0.23	7.66 ± 0.23	7.81 ± 0.08	4.81 ± 0.08
F- value	0.21	0.54	2.26	2.05	2.08	1.46	2.16
Probability	0.02^{NS}	0.04^{NS}	0.03*	0.02*	0.02*	0.01^{NS}	0.03*

Values are expressed as mean ± SD, *Significant at 5% level, NS: not significant

Table: 2 represents the mean sensory scores of the soups prepared from 6 protein rich formulations. From the table can be inferred that there was significant difference among the soups only with respect to taste, flavour, and overall acceptability at 5% level. It can be further concluded that soups containing either skim milk powder or little millet in higher proportion (i.e formulations 1, 2, 5, 6) when compared to soups containing nearly equal proportions of skim milk powder and little millet flour i.e. (formulation 3, 4,). Soup prepared from formulation 3 had significantly higher mean sensory scores for taste, flavour, and overall acceptability. Table: 3 represents the mean sensory scores of the dosa prepared from 6 protein rich formulations. It is clear from the table there exist significant difference at 5% among the dosa's with respect to all parameters. It is suggestive from the table that increase in quantity of skim milk powder proportion in the formulation negatively affected the sensory properties of dosa. Dosa prepared from formulations 4 and 3 are statistically significant over others and there is no significant difference between dosa's prepared from formulations 3 and 4. Table: 4 represents the mean sensory scores of laddo's prepared from 6 protein rich formulations. It can be concluded from the table that there is statistically significant difference among the laddo's with respect to taste, flavour, after taste and over acceptability. It is indicative from the table that presence of higher proportion of little millet flour in mix did not affected colour, appearance, consistency parameters but taste, flavour, after taste and over acceptability were negatively affected. With respect to taste, flavour, after taste and over acceptability laddo's prepared from formulations 3 and 4 are have higher scores among all. From the above tables it can be concluded that formulation 3 has highest sensory scores for soup, dosa and laddu in common. So, formulation 3 is selected for the evaluation of nutritional parameters.

Proximate composition of the best accepted mix

Table 5: Proximate composition of best accepted mix

Moisture	**8.90%**
Protein	17.2%
Fat	1.83%
Ash	1.5%
Crude fibre	2.12%
Carbohydrate	67.60%
Energy	355.33 K. Cal

Moisture: the moisture content of mix was found to be 8.90 which meets the specification of not more than 15.5% moisture in flour blends, as given by Codex-Alimentarius, 2016. Wakeel (2007) [16] reported that when the moisture content of foods is less than 10%, such materials are considered as more proper for keeping quality of soup ingredients. Hence, it is evident that the moisture content of the mix was within the acceptable range suggesting higher microbiological stability and longer shelf life. Protein: It was found that protein content of the mix was 17.2%. The protein content of the present mix was similar with protein content of the composite mix prepared from millet flour (60%), skim milk powder (30%) and vegetables (10%) (Tumwine *et al*., 2018) [15]. Presence of good quantity of protein in the mix indicated that if 100 grams is consumed (either in the form of dosa, laddu or by incorporating in to chapatti) it meets 31.1% and 28.60% of RDA of reference women and man respectively (Krishnaswamy 2011) [8]. Thus this mix helps to ensure adequate supply of protein. Ash: The ash content of mix was found to be 1.5%. The ash content of the mix was closely related to the ash content (1.66%) of the composite millet mix containing 50% finger millet; 20% kodo millet; 20% little millet; 10% Barnyard millet. This indicates effective combination of skim milk powder, little millet and green gram dhal flour upholds ash content similar to that of finger, little, kodo millet which are fairly good sources of minerals. (Ranganna *et al*., 2014). Fat and crude fibre content of mix were 1.5% and 2.12%. The results of the present study are in agreement with the fat and crude fibre content of composite mix prepared by mixing 70% wheat flour, 10% chick pea flour, 10% finger millet flour and 10% barley flour i.e.1.7 and 2.2% respectively. (Tangariya *et al*., 2018) [14] Carbohydrates and Energy: it was established from the study that carbohydrate and energy content of the mix was 67.60% and 355.33 K. Cal respectively. Similar results in terms of carbohydrates and energy content were reported by Tumwine *et al*., 2018 [15] where carbohydrate, energy content of the composite mix prepared from millet flour and skim milk powder was 69% and 370 K. Cal respectively.

If 100 grams of present mix is consumed it meets following % of RDA of reference man and woman:

		% RDA of energy
Reference man	Heavy worker	10.45
	Moderate worker	13
	Sedentary worker	15
Reference woman	Heavy worker	12
	Moderate worker	15
	Sedentary worker	18

Conclusion

From the present study it can be concluded that skim milk powder, little millet flour and green gram dhal in combination can be used effectively to develop protein rich mix.

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